IOWA STATE UNIVERSITY
Digital Repository

Volume 1 | Number 2 Article 6

February 2017

Arsenic Experiments

C. P. Gillette
Iowa Agricultural College

Arsenic Experiments.

By C. P. Gillette.

The great value of arsenic in the forms of Paris green and London purple for the destruction of leaf-eating insects has long been recognized. As pure white arsenic in solution is occasionally recommended to take the place of the above named arsenites, and as I have been repeatedly urged to recommend its use on account of its greater strength and cheapness, the following experiments were made for the purpose of determining whether or not it can be safely used in this way for insecticidal purposes:

One part of arsenic is soluble in 10 parts of boiling water and in 100 parts of cold water, the solution being as clear as the water used and remaining for an indefinite length of time without any sediment forming.

In order to have solutions of known strength throughout, one ounce of arsenic was in each case dissolved in a gallon of boiling water for a standard solution, and from this solutions of desired strengths were made.

On June 23d solutions of various strengths ranging from 1 pound of arsenic in 200 gallons of water to 1 pound in 800 gallons were applied to the foliage of various plants and trees. June 26th a heavy rain set in, and for nearly twenty-four hours the leaves received a constant wash. On June 27th the following notes were taken:

Apple Foliage. One to 200 and 1 to 250 have scorched at least, one-half of the leaf surface; 1 to 400 has scorched only the tips and edges of the leaves.

Plum Foliage. One to 200 and 1 to 250 have hardly left a green leaf; 1 to 400 and 1 to 500 have scorched badly the entire foliage; and 1 to 800 has damaged the leaves too badly to allow this strength to be recommended.

Grape Foliage. One to 200 has spotted the leaves badly; 1 to 250 has damaged the foliage almost as much as the preceding; 1 to 400 and 1 to 500 have damaged the foliage but little, the latter almost none.

Box Elder. One to 200 and 1 to 250 have burnt about one-half of the foliage to a crisp; 1 to 400 has burned the leaves badly; 1 to 500 has spotted and scorched the edges but little; 1 to 800 hardly shows any effect at all.

Honey Locust. One to 250 is turning all the leaves brown; 1 to 400 and 1 to 500 are both burning the leaves badly.

American Elm. One to 200 and 1 to 250 have browned the edges of the leaves a little, and the weaker strengths do not show at all.

Poplar Foliage. One to 800 scorched the leaves badly.

Silver Maple. One to 200 and 1 to 250 have each destroyed about one-half of the foliage; 1 to 400 has burnt the leaves too badly to be recommended; 1 to 500 has injured the foliage some but not seriously; and 1 to 800 has done no perceptible harm.

Raspberry. One to 500 has destroyed about one-half of the surface of the leaves.

Garden Weeds. As it was convenient to do so, some of the solutions were applied to a luxurient growth of weeds in a garden, among which were red-root, pig-weed, burdock and plantin. The effects of the same strength on the different weeds were so similar that I will give them together. One to 200 and 1 to 250 caused nearly all of the leaves to droop and die; 1 to 400 and 1 to 500 scorched the plants badly; and 1 to 800 showed its effects, although it damaged the plants but little.

Before giving other experiments, it should be mentioned that when the above notes were taken the arsenic had not yet completed its damaging effects on the trees and plants above mentioned. Notes taken two weeks later showed the damage fully double in many cases. For example, 1 to 200 did not leave a green leaf on plum and destroyed more than 90 per cent. of apple foliage; 1 to 400 destroyed about one-half of the foliage of box elder, entirely destroyed the leaves of honey locust, hardly left any green leaves on raspberry, and spotted and scorched the edges of the leaves of the elm a good deal; 1 to 800 on plum destroyed at least 75 per cent. of the foliage.

On July 7th another series of applications were made on plum and apple foliage, in which the dilutions were carried to one pound of arsenic in 1,200 gallons of water. These trees were selected for two reasons: first, because it is on these two trees that arsenic solutions have most often to be applied; and second, because plum leaves are among the most susceptible and apple leaves among the least susceptible of all foliage to injury from arsenic solutions. So that a solution of arsenic that will not injure plum can be safely recommended on very delicate foliage, and a solution that will injure apple leaves cannot be recommended on even the most hardy leaves without first experimenting to find out whether or not it is safe.

As the second series of experiments runs so nearly parallel with the first, I will economise time and space by summarizing the results.

The proportions of pounds of arsenic to gallons of water used are as follows: 1 to 200, 1 to 300, 1 to 400, 1 to 600, 1 to 800 and 1 to 1,200.

The applications were made between one and three in the afternoon, and before the next morning a heavy rain set in that lasted through the greater portion of the day.

Plum. Twenty-four hours after the treatment plum leaves showed plainly the effect of the treatment; three weeks after the application there was scarcely a green leaf on plum trees where the strength exceeded 1 to 600; and 1 to 200 not only took all of the leaves, but killed all of the small twigs as well; 1 to 1,200 took off about half of the leaves and left the remainder looking sickly and somewhat burned.

Apple. The three weakest dilutions, 1 to 600, 1 to 800 and 1 to 1,200 differed little in their effects. In any of these cases it is difficult to find a leaf not damaged, the amount of harm varying in each case from a small spot to more than half of the leaf, and some of the leaves, on account of the treatment, have fallen to the ground. The stronger solutions did much more harm, 1 to 200 leaving but a few scattering leaves and they with a large portion of the surface burned to a crisp.

Two other series of experiments were made, but the results coincide so perfectly with the preceding that I will not take space to enumerate them.

Effects on Insects. Deeming it thoroughly proven that arsenic could not be used in solution stronger than one pound to 1,200 gallons of water, a portion of an apple tree was thoroughly sprayed with this solution, and the leaves gathered daily and fed to larvæ of Datana ministra. After feeding on the poisoned leaves for five days the worms gave no signs of failing health and the experiment was discontinued.

WHY SOLUBLE ARSENIC BURNS FOLIAGE.

It may seem strange at first that dissolved arsenic in so small quantities should injure foliage when London purple or Paris green, which are nearly one-half as strong in arsenious acid, can be used in the proportion of one pound to 150 gallons of water on the most delicate foliage without doing perceptible harm. The reason seems evident, however, on a second thought. It is certain that only that part of the arsenic that is in a soluble condition can act on the leaves to corrode them. Paris green and London purple do not dissolve in water, except in very minute quantities. Their finely divided particles are simply held in suspense in the water and when the latter evaporates these particles remain in an insoluble condition on the surface of the leaves where they may be plainly seen by the aid of a microscope.

The white arsenic, on the other hand, is so perfectly soluble in the proportions used that it is able to pass quickly by osmosis into the substance of the leaves, and produce its evil effects.

ANALYSIS OF LEAVES.

For the purpose of determining whether or not the soluble arsenic does penetrate the substance of the leaves, and whether the arsenic would all be washed off by the first heavy rain, several tests for arsenic were made. For these tests I am indebted to Professor G. E. Patrick, the Station Chemist.

On the morning of July 9th twigs from apple and plum trees were gathered that were treated July 7th with the solution 1 to 200, It will be remembered, as before stated, that this application was followed in the night by a rain fall that lasted for nearly twelve hours. The apple and plum leaves were taken separately and thoroughly washed, the water being changed many times, and in each case the first wash water and the leaves were saved to be examined for arsenic by the Marsh test.

The water from the plum leaves gave only a faint trace of arsenic. The water, in which the apple leaves were washed gave a somewhat better test indicating that the fuzzy exterior of the latter leavas enables them to retain more of the poison on their surface. The leaves were then examined and sufficient tests to ensure the presence of artenic, were obtained in either case, but the amount was exceedingly small. Supposing the poison to have been entirely washed from the surface of the leaves, this would be sufficient proof that the arsenic did enter the substance of the leaf. To make sure that this was the case, other leaves were sprayed and treated as follows: Fifteen hours after spraying, leaves were picked, and thoroughly washed in hydrate of soda, which is a ready solvent of arsenic, in order to remove all traces of the poison from the surface. This wash was then poured off and saved and the leaves washed many times in pure water. The soda wash, the last two wash waters, and the leaves were then tested for arsenic, which resulted as follows: The soda wash gave abundant tests. The last two waters combined gave no trace whatever. The leaves gave abundant tests, but there seemed not to be as much arsenic present as in the first wash. This I beleive to be sufficient proof, that the arsenic did enter the substance of the leaves and that very quickly after being applied.

Whether white arsenic can be advantageously applied in cold water, is a subject still open for investigation. But in this case the application would have to be made before the arsenic had time to become thoroughly dissolved, and before solution takes place the arsenic is so heavy that it settles rapidly to the bottom of the vessel, which necessitates constant stirring.

When we add to these facts the increased danger to human life, that is incurred by having in the house so deadly a poison that cannot be distinguished in color from flour, saleratus, baking powder, and other materials used in

cooking, and the other fact that London purple, which is also a waste product, can be had almost as cheap as arsenic, it would be unwise in the extreme to recommend the latter, especially if it be in solution, for insecticidal purposes.

HOW TO SPRAY,

There is an opinion more or less prevalent that the arsenites when thrown with much force, will be driven into the surface of the leaf so as to do more harm than if applied in a gentle spray. To test this point four apple trees of the same age and variety standing side and side were sprayed with the same preparation of London purple. The pump used was Nixons Barrel Machine, In the first case a number 3 nozzle, complete, was used which threw a very gentle spray that was directed on all parts of the foliage of two of the trees until every leaf seemed thoroughly wet above and below. In the other case the gauze on the end of the nozzle was removed and the direct stream thrown upon the two remaining trees with all the force that could be had, especial pains being taken to hit the underside of the leaves. The strength of the mixture was one pound of the Londen purple to one hundred gallons of water, In both cases the foliage was somewhat burnt but not seriously and I could not see that the damage was more in the latter case than in the former.

Other experiments were tried by throwing a fine spray so as to have it fall only on the upper surface of the leaves and then again so as to have it fall on both surfaces. Wherever this was done, the damage sustained by the leaves that were wet on both sides was fully double that sustained by those wet only on the upper surface. Twigs were also dipped in arsenic solutions and the effect compared with those that were thoroughly and forcibly sprayed but no difference could be seen in the amount of damage to the folige.

That forcible spraying does, in ordinary cases, damage foliage worse than gentle spraying I have no doubt, but I believe the reason for it to be found in the fact that the leaves are more thoroughly treated in the former case than in the latter.

LONDON PURPLE AND PARIS GREEN.

In this connection it will be well to state the proportions in which the arsenites, Loddon Purple and Paris green, can be safely applied to foliage.

The maximum strength in which London purple should be applied to apple foliage I would put at 1 lb, to 100 gallons and I do not think it advisable to apply it weaker than 1 to 160.

Paris green, which contains a little larger percent of arsenious acid, should not be applied to apple foliage stronger than 1 to 120 nor weaker than 1 to 180 ; and on plum not stronger than 1 to 160 nor weaker than 1 to 200.

Although weaker resolutions than any above mentioned might often prove efficient, I do not think it advisable to use them as a few heavy dews, or a light rain would remove a sufficient amount of the poisons to make a second application necessary, and either of these arsenites can now be purchased very cheaply.